applications of sumach, sulphate or acetate of iron, sulphate of copper, logwood, and fustic,—the end chiefly aimed at being the production of a black with blush or violet bloom. The Manchester dyers formerly held a monopoly of this blue-black upon velvet, as it is called, but of late years the German dyers have shown themselves very formidable competitors in dyeing this class of goods.

Theory of Dyeing.

When the great variety of processes employed in dyeing is taken into consideration, it is apparent that there must be some difficulty in constructing a general theory which shall be applicable to every case.

The earlier writers who endeavoured to generalize the principles of the art considered that the particles of colour were mechanically deposited in the pores of the fibre. The use of chemical substances in dyeing was held necessary only to dilate the pores for the admission of the particles, to prepare the particles for entrance into the pores, or to close up the pores after the colouring particles had entered. Mordants were held to be necessary because they formed cavities in the fibre adapted by their size and shape to receive and retain different kinds of coloured particles. About the middle of the last century Bergmann, observing the dyeing of wool by sulphate of indigo, considered that what took place was a purely chemical action, and that the matter of the wool entered into chemical combination with the dye-stuff, changing it from a soluble into an insoluble substance, and showing therein the power of chemical affinity. From this time the mechanical or physical theory of dyeing was supplanted by a chemical theory, in which all the observed facts were explained by the assumption that chemical forces operated between the fibre and the mordant, or the fibre and the colouring matter. A closer consideration by a later generation of chemists of all the phenomena of dyeing and of the nature of the materials employed did not tend to support this theory. About 1840 Dumas, the celebrated French chemist, and Crum of Thornliebank, a skilful chemist and a practical dyer, formally disputed the existence of a chemical action in dyeing, and referred the phenomena to physical causes of attraction on the part of the fibre. Crum confined himself to the single case of the dyeing of cotton, and expressed himself convinced that it was owing either to surface contact of the dye stuff with the cotton or to its entrance into the hollow tubes of the same, the colours produced in the first case not being so stable as in the other, as far as resisting friction went. The power which cotton fibre evidently possesses of appropriating oxides from solutions, as well as colouring matters, such as indigo, was viewed by Crum as a case of surface attraction, similar to the power residing in charcoal of abstracting oxides and colouring matters from solutions, and he declared there was no such thing as a chemical combination between the cellulose of the cotton fibre and any of the chemical substances or dye materials. To controvert this statement is difficult, for, though the forces at work seem to be chemical forces, the products cannot be proved to be definite chemical compounds. On the other hand, the forces of catalysis, surface attraction, and powers of porous substances which Crum substitutes for the chemical forces of the older theories of dyeing, may be said to be merely names, without definite meaning, for indicating the existence of a class of phenomena not at all understood even at the present day. Dumas views the questions more broadly, and simply declines to accept as chemical phenomena actions which do not produce real chemical compounds. He considers that dyeing is more probably owing to a physical property of fibres by which they are enabled to attract and retain coloured bodies, much in the same way that animal charcoal does, and simply because the nature of the powers exercised by charcoal are not accepted as chemical, and no one knows what they are, dyeing cannot be considered as an effect of chemical attraction or affinity. He admits, however, that there are some powers at work different from that possessed by charcoal. How is it, he asks, that wool takes up the scarlet dye so well under conditions where silk and cotton are barely tinged with colour? How is it that wool unites with the black precipitate formed with tannin and iron salts, while silk under the same circumstances is so difficult to dye? He asks, finally, how it is that certain colours can be fixed better on some fibres than others; and whether it is not by some special action, not correctly called affinity, but which at any rate is an important force, or the resultant of several forces, that this is affected. But, he continues, to confound chemical affinity, properly so called, with the phenomena of dyeing is to confound two very different things. When silk unites with Prussian blue, or wool with indigo, the action is quite distinct from what takes place when sulphur combines with lead. But, on the other hand, again, fibres are not to be looked upon as acting simply the part of a filter in retaining colours.

Chevreul, at a later date, insists that in the present state of our knowledge the phenomena of dyeing can be explained only upon chemical principles. He admits that colour may be and in practice is frequently deposited upon the external parts of fibres, but there are numerous cases in which a soluble salt is decomposed by fibrous matters, as when silk is steeped in persulphate of iron; and he cannot consider as anything else than chemical affinity that power which enables a solid body to decompose a solution of elements, themselves united by chemical affinity, and which without the contact of the solid body would have remained in perfect union. Many other chemists, physicists, and microscopists have occupied themselves upon this vexed question, but without evolving any generally acceptable theory of dyeing. The balance of opinion may be said to be in favour of the supposition that as far as regards the animal fibres, wool and silk, there are many cases of dyeing which can only be regarded as effected by chemical powers; with respect to the vegetable materials cotton and linen, the evidence is less certain, and we must wait for further research and investigation to settle the disputed question.

Books of Reference.—Of the numerous works upon dyeing it may be sufficient to mention Bancroft's *Philosophy of Permanent Colours* (2d ed. 1813); Berthollet's *Éléments de la Teinture*, and Ure's translation of the same into English (1841); Persoz's *Traité de l'impression des Tissus* (1846),—a most complete and accurate work for its date; O'Neill's *Chemistry of Calico Printing and Dyeing* (1860), and *Dictionary of Dyeing* (1862); Napier's *Manual of Dyeing* (3d ed. 1875); Schützenberger's *Traité des Matières Colorantes* (1867); Crookes's *Dyeing and Calico Printing* (1874); and Crace-Calvert's *Dyeing and Calico Printing* (1875). Of periodicals specially devoted to the application of colouring matters to textiles there is only one in Great Britain, *The Textile Colourist*; Germany has the *Färber-Zeitung* and the *Muster-Zeitung*; in France there are the *Moniteur de la Teinture* and *Le Teinturier pratique*. Original articles upon the subject occasionally appear in the chemical journals, and especially in the Bulletins of the Industrial Societies of Mulhouse and Rouen. (C. O'N.)

DYER, John, English poet, was born in 1699 or 1700 at Aberglasney, in Carmarthenshire, where his father, Robert Dyer, successfully practised as a solicitor. He was sent to Westminster school to be educated under Dr Friend, and was destined to succeed to his father's business. He showed, however, an inveterate dislike to the study of the law, and, having a taste for design, he induced his parents to allow him to adopt the profession of an artist. He wandered about South Wales, sketching landscapes and occasionally painting portraits. In 1726 his first poem, *Grongar Hill*, appeared in a miscellany published by Richard Savage, the poet. It was an irregular ode in the so-called Pindaric style, but Dyer entirely rewrote it into a loose measure of four cadences, and printed it separately in 1727. It had an immediate and brilliant success. *Grongar Hill*, as it now stands, is a short poem of only 150 lines,

describing in language of much freshness and picturesque charm the view from a hill overlooking the poet's native vale of Towy. Artless in an affected age, the natural images which crowd upon one another in this charming little poem are as admirable now as when they were written, and hold an assured place in English literature. Dyer's ambition to succeed as a painter impelled him to visit Italy, and about ten years after the publication of *Grongar Hill* he seems to have attained this great desire, and to have spent some time in the south of Europe. It was in consequence of this tour that he wrote his next poem, *The Ruins of Rome*, a descriptive piece in about 600 lines of Miltonic blank verse. In this work the phraseology is pompous and conventional, but there is considerable knowledge displayed, and the ardour of a true lover of antiquity. *The Ruins of Rome* appeared in 1740, and increased its author's reputation. Having fallen into bad health while painting in the Campagna, and finding that he was not destined to excel in the practice of art, he determined to enter into holy orders. In 1741 he was ordained by the bishop of Lincoln, and presented with the living of Calthorpe, in Leicestershire. He was married about this time to a lady descended from the brother of Shakespeare. In 1751 he was translated to the living of Belchford, in Lincolnshire, to which was added in 1752 that of Coningsby. In 1756 he exchanged Belchford for the wealthier incumbency of Kirby-on-Bane. In 1757 he published his longest work, the didactic epic of *The Fleece*, in four books, of which the first discoursed of the tending of sheep, the second of the shearing and preparation of the wool, the third of weaving, and the fourth of trade in woollen manufactures. The subject was prosy, and the stately blank verse in which it was discussed gave the poem a ridiculous air. The town took no interest in it, and the wits facetiously prophesied that "Mr Dyer would be buried in flannel." He did, in fact, very shortly afterwards follow his poem to the grave, for he died of consumption on the 24th of July 1758, leaving a wife and four children. After his death his genius was defended and his writings analyzed by Scott of Amwell, who published a commentary on Dyer's poems. The latter were collected by Dodsley in 1770, but they only form one small volume. *Grongar Hill* has been compared with Sir John Denham's *Cooper's Hill*, which may in some measure have suggested it. These two pieces remain the most important topographical poems in English literature, if we exclude Ben Jonson's *Penshurst*.

DYNAMICS properly means that science which treats of the action of force. Defining force as that which affects the motion of matter, it appears that the study of dynamics will lead to the consideration of the motion of material systems, and the laws in accordance with which this motion is changed by the mutual actions of the bodies forming such systems. But there is a sense in which we may contemplate the geometrical results of the motion of bodies without studying the forces under which, or the time during which, it takes place; and hence there are many problems which at first sight we might be disposed to include under the head of dynamics, but which also belong to the domain of pure mathematics, and may therefore more properly be considered as a branch of geometry. On the other hand, there is a branch of dynamics which treats of pure motion without taking any account of its subject or the means by which it is produced or changed. In this branch, to which the term kinematics, though first employed by Ampère in a wider sense, may with propriety be confined, it may seem that no consideration of matter or of force is involved; but, unlike the class just alluded to, the problems which come under this head involve explicitly the element of time, and it is only after studying the laws of dynamics that we are able to furnish a theoretical measure of time satisfying the demands of the human mind. Thus any subject in which the measurement of time is involved enters on this account into the domain of dynamics.

Measurement of Time.—For ordinary purposes the rotation of the earth furnishes a sufficiently exact means of measuring time, and the observation of the transit of a known star is the best method we possess of determining the error of a clock; but that the fundamental conception of the measurement of intervals of time is based upon other foundation than the diurnal rotation of our planet at once appears from the fact that we see no inconsistency in asking whether the length of the day is the same now as it was 2000 years ago. If our primary conceptions of the measurement of time were derived from the earth's rotation, the absolute constancy of the length of the day would be a matter of definition. But it is not to the motion of the earth or of any other single body that we are indebted for our highest conception of the measurement of time—it is rather to the dynamical principle expressed in the first law of motion; and hence it is that the theoretical measurement of time, and of other physical quantities which explicitly involve time, must find a place under the head of dynamics. Kinematics may therefore properly be treated as a branch of dynamics, and for its discussion, as well as for the enunication and explanation of the laws of motion, the reader is referred to the article on Mechanics.

Perhaps there is nothing which appears to present a subject for study simpler than that afforded by the properties of space, and hence it is that geometry attained so high a reputation and made such rapid advances among the ancients. It was easy to construct material standards of length and by their means to measure approximately the linear dimensions of limited portions of space, the human mind being only too ready to believe in the constancy of the dimensions of the standards constructed; and thus the properties of space presented a subject which, at the very outset, afforded a facility for investigation which was wanting in the study of other physical quantities. The great simplification introduced by this belief in the permanence of the dimensions of material standards will be apparent if we consider the position in which we should be placed by the adoption of a different hypothesis. Once admit the supposition that the properties of a figure, as regards dimensions or form, depend explicitly on its position in space, or upon time, either by a process of growth in themselves or because space is changing its character, and the whole subject of geometry will require reconsideration.

Displacement.—A number of points or figures may be connected in accordance with such geometrical conditions that if one or more be displaced in a given manner the displacements of all the others may be determined. The determination of the displacement of each in terms of the given displacements is a problem in pure mathematics, and the branch of geometry which treats of such questions may be called the science of displacement. If we suppose the figures here contemplated to be material bodies, and the geometrical conditions to be determined by means of material constraints such as links, guides, teeth, and the like, the science of displacement thus applied becomes that of mechanism, and it is only necesary here to call attention to the following statements. First, in the study of displacements, or of pure mechanism, no account is taken of any but the geometrical properties of the bodies displaced, while the forces engaged in producing the displacement are entirely neglected: the consideration of the mechanical properties of the materials of which the parts of a machine are constructed, the forces acting between those parts, and the best means of "fitting" them, belongs to applied mechanics and machine construction. Secondly, the element of time is altogether left out of consideration: for, although it may be argued that the displacement of each part of the system takes place in the same interval of time, and that the geometrical conditions enable us to compare the displacements experienced by different parts during the same time, and thus lead us to a comparison of velocities, yet it must be observed that this is *only* a comparison amounting simply to a relation between corresponding displacements, and does not involve time explicitly, since the whole displacement may take place in a time as long or as short as we please, for we do not consider it. Moreover, the actual motion of any part may be made uniform or varying in any arbitrary manner without any account being taken of it. In fact it is simply two or more configurations of the material system which are compared together, and, though for the sake of distinction we call one the initial and another the final configuration, we might as well distinguish them in any other manner and without stating which follows the other. Indeed we contemplate them as co-existent during the act of comparison. Hence we may complete the science of displacement or pure mechanism without ever considering force, or being able to measure time or even to define equal intervals.

Kinematics.—If to our conceptions of space and of displacement we couple that of time *as a measurable quantity*, we are led to compare the rates of non-simultaneous as well as of simultaneous displacements, and are consequently obliged to measure the *rate* at which displacement occurs by the change of position experienced in a *definite interval of time* by the body, figure, or point we are regarding. Rate of change of position measured thus we call *velocity*. The next step in the same direction is the consideration of the rate at which velocity changes, or *acceleration*, and thus the association of our conception of space with that of time as a measurable quantity opens up to us that branch of dynamics which we call kinematics.

Matter.—Having considered displacement in connection with the time during which it occurs, the next step leads us to take account of the thing displaced, and here we are obliged to contemplate matter directly. Matter, like time and space, we do not attempt to define, but treat it as a primary conception, its more obvious properties making themselves known to all through daily experience.

Force.—The change of the motion of material bodies brings us at once, through the introduction furnished by the first law of motion, to the conception of force, which may be defined in terms of three primary quantities, viz., space, time, and matter. The second law of motion expresses the manner in which matter is affected by force, and teaches us how to measure force by the observation of its effects.

The science of dynamics in its restricted sense is that which treats of the consequences arising from the relations of matter to force, and before we can proceed in this science beyond the first step we must become acquainted with the second law of motion, while kinematics requires for its complete development only the first law of motion, its range being thereby sharply defined and separated from that of the rest of dynamics. The laws of motion, like other natural laws, must be understood to express merely the properties of natural bodies as we find them, and within the degree of accuracy to which our experiments can be relied on. We might, of course, have started with any hypotheses we liked respecting the relations of force to matter, and upon these hypotheses and our conceptions of time and space have constructed a purely theoretical system of dynamics which would have been perfectly self-consistent; but our conclusions might, or might not, have agreed with observations of natural phenomena. If we found an agreement between the results of the application of our theory to special problems and the solutions of the corresponding problems as worked out objectively in nature, we should have reason to believe that our hypotheses agreed with the facts, or, in other words, that they were true, and we should then raise them to the dignity of natural laws. It is on evidence of this kind that our acceptation of all natural laws is based. If our conclusions were inconsistent with natural phenomena our system of dynamics would be an abstract, instead of a natural, science—if, indeed, it might be called a science at all—and would be valuable merely as an intellectual exercise. In the case of such an abstract science we are not even bound to adopt the axioms respecting the properties of space which are usually accepted, but may confer upon our "space" any number of dimensions and any properties we please.

Stress.—Though the conception of a single force is convenient, it nevertheless results from a mere process of mental abstraction. We never meet with a single isolated force in nature, but each is accompanied by an equal and opposite force acting in the same straight line, and when we speak of one without the other we do so merely for the sake of brevity. The third law of motion implies this statement, though it has also a wider signification. The action and reaction which are thus always inseparably linked together may be conveniently called a stress, of which the two forces are opposite aspects. Thus it appears that there is nothing in nature corresponding to what we are accustomed to call a single force; stresses, indeed, abound, and may be produced whenever we please, but we are completely ignorant of their existence except when they change the relative velocities of different portions of matter. Then, and then only, do they appeal to our senses.

Statics.—The investigation of the conditions under which a system of stresses produces no displacement of the bodies between which they act constitutes the science of statics, and will be discussed under the head of MECHANICS.

Measurement of Force.—Since force can be defined in terms of space, time, and matter, it follow that the measurement of a force ought to involve measurements of these three quantities and of them only. Now it is plain that any force whatever may be chosen as the unit in terms of which other forces should be expressed, provided it is capable of being reproduced at all times and in all places with precision. We all now believe that the quantity of matter in a body is unchanged by changing its position or by the simple lapse of time, and we also believe that the region of space which we inhabit is sufficiently homoloidal to allow us to compare distances in different directions, at different places, and at different times. Moreover, the first law of motion, as has been stated above, provides, when proper precautions are taken, a method of measuring time which satisfies the requirements of the mind, while the rotation of the earth affords a practical measure of time sufficiently exact for the most refined experiments we can execute. Therefore a unit of force which depends only on the units of length, mass, and time will be the same at all places, and, so far as our experience allows us to judge, at all times. Such a unit is termed an absolute unit. Not only force but every other quantity dealt with in dynamical science, as well as every physical quantity whose relations to space, mass, and time are known, can be measured in terms of a unit of its own kind which depends only on the fundamental units of length, mass, and time, and is then said to be expressed in *absolute measure*. The three primary units must be chosen in an arbitrary manner, and their permanence must be considered a matter of definition; but when these have been once fixed, all the absolute units derived from them are perfectly determinate and invariable. If a foot, a pound, and a second be chosen as units, the corresponding absolute unit of force is called a *poundal*; while if the primary units be a centimetre, a gramme, and a second, the unit of force is called a *dyne*.

For the definitions of the derived dynamical units and the investigation of their dependence on the fundamental units, the reader may refer to the article on MECHANICS.

From what has been said it will appear that the whole difficulty in fixing upon a system of dynamical units lies in the determination of the fundamental units of length, mass, and time in such a manner that their constancy can be relied upon. The unit of mass offers very little difficulty in this respect. Long experience has taught us which are the most permanent of the varieties of matter we have at command. We have good reason to believe that a piece of platinum or an alloy of platinum and iridium may be exposed to pure air at ordinary temperatures for an indefinite time without any increase or diminution of its mass whatever. Such a piece of metal may therefore with propriety be chosen as a national standard of mass, the *absolute* constancy of the quantity of matter constituting it being accepted on definition, as we are unable to test it by any standard in which we have more confidence than we have in itself. The British and French national standards of mass are of platinum, but the new standards recently constructed in Paris consist of an alloy of platinum and iridium.

The determination of a unit of length is not so simple as that of the unit of mass. In this case, as in the preceding, we avail ourselves of the properties of a material standard, but we know that however indestructible the standard itself may be its dimensions depend upon the pressure to which it is exposed, its temperature, and in some cases upon other accidents, such as the magnetic force in the neighbourhood, &c. Hence the only course open to us is to determine as far as possible all the causes of variation in the length of our standard, and carefully to define its condition with respect to these variables, so that it shall be a standard only under the circumstances thus defined. Having thus defined the condition of the material standard with respect to all the variables upon which we know its length to depend, we must consider the *absolute* constancy of its length at all times and places to be a matter of definition until we have discovered other causes which affect it. It has been proposed that the wave length *in vacuo* of a particular kind of light, as for instance that corresponding to one of the sodium lines, should be taken as the unit of length, and its period as the unit of time. These units are probably more constant than those afforded by any material standards or vibrating springs which we can construct; but a belief in their *absolute* constancy implies complete confidence in the constancy of the properties of the interstellar medium, and of the sodium molecule.

The determination of a satisfactory means of measuring time seems to offer greater difficulties than the measurement of mass or of space, though the difficulties are of the same character as those we have just considered. The great difficulty consists in defining what is meant by the equality of two intervals of time which do not commence simultaneously. Remembering that it is upon the properties of matter alone that we can rely for assistance, we might construct a spring and define as equal lapses of time those intervals during which this spring executes the same number of vibrations, the temperature, &c., being kept constant. But if we were to construct a number of such springs, though a perfect agreement might obtain between them at first, we should find after a considerable period that the measurements of time derived from different springs did not agree, while our knowledge is insufficient to enable us to apply to each the corrections necessary to lead us to a consistent result. Now there may be no reason why we should prefer one spring above all the others, and thus it appears that a definition of equal intervals of time based upon the behaviour of any single spring is too arbitrary to be satisfactory. If, however, we found a large number of springs, constructed of different materials and differently affected by temperature and other known causes of variation, continue to give perfectly consistent results, the theory of probability would lead us to place a high value upon the measure of time thus afforded. Now, we have stated that our highest conception of the measurement of time is derived from the dynamical principle expressed in the first law of motion, but when we come to apply this it is impossible to determine *a priori* whether in the case of two given bodies there is no stress acting between them or between one of them and some third object. Consequently, the only course open to us is to examine the motion of a large number of material systems, making such corrections for the action of stresses which we know to be in operation as our theoretical dynamics will enable us to determine; and, if after this we find that several independent systems afford the same measurement of time, while those systems which lead to a different result disagree also among themselves, we must accept the measurement of time afforded by the first set as the true measure, and attribute the discrepancies manifested by the other systems to some unknown stresses, which it should be our subsequent business to discover.

Work.—The contemplation of a stress, together with a relative displacement of theportions of matter between which it acts, introduces us to the conception of *work*. If we consider a stress, together with the distance through which the solicited bodies are capable of moving relative to one another in obedience to the stress, the object of our contemplation is the work which may be done under the given conditions of the system, and this we call *energy*. The subject of which natural philosophy treats is the transformation of energy, which in all its phases takes place in accordance with two great principles, known respectively as the principles of the conservation and the dissipation of energy. Of these two principles the former rests upon a much higher scientific basis than the latter. In order to lose our faith in the principle of the conservation of energy we must give up our belief in the fundamental principles of dynamics expressed in the laws of motion; but as regards the dissipation of energy we can say little more than that all the operations of nature with which we are acquainted take place in accordance with this principle. Clerk Maxwell has, however, shown that it is possible to subvert the principle of the dissipation of energy by the simple exercise of a sufficiently high order of intelligence. For the statement and discussion of these two principles see ENERGY.

It is the work of the natural philosopher to explain the operations of nature in accordance with the principles of dynamics, and we consider that we understand any phenomenon when we have shown it to consist of a motion of matter and determined the character of this motion. Thus it is that dynamics forms the foundation of every branch of natural philosophy, and a thorough appreciation of the principles of conservation and dissipation of energy is the only safe guide in physical investigations. (W. G.)

DYNAMITE (δύναμις, strength), the name applied to various explosive preparations containing nitroglycerin. The first practical application of nitroglycerin, discovered by Sobrero in 1847, was made by Alfred Nobel, who in 1863 used gunpowder soaked with it for blasting. In 1864 he found that it could be exploded by the initiative detonation of fulminating materials; and in 1867, owing to the uncertainty and danger attending its employment, he conceived the idea of mixing it with some solid and absorbent inert substance. The siliceous infusorial earth called in Germany *Kieselguhr* proved to be well adapted for this purpose, since it took up as much as three times its weight of nitroglycerin without becoming more than damp to the touch. The mixture of earth and nitroglycerin, to which was added a little alkaline material to neutralize any acid that might be set free by the latter, was termed by Nobel dynamite. Ignited in the open air, dynamite burns slowly, but it is as readily exploded as nitroglycerin itself by means of a detonating fuze; and, though not equal in bursting or breaking power to uncombined nitroglycerin, on accouut of the absorption by its inert constituents of part of the heat developed by the exploding shock, it is greatly superior to gunpowder, instead of which or gun-cotton it is employed in blasting coal and stone, removing piles, felling trees, and clearing stumps from forest-land. It may also be used with advantage for the destruction of cannon and for breaking up large iron castings (see *Compt. rend.*, lxxii. 770). For filling bore-holes its pasty consistency renders it a very convenient material.

In continuous masses dynamite transmits detonation at the rate of from 19,500 to 21,600 feet a second. Confinement is not requisite for its explosion, and it can be used in damp situations without to any great extent impairing its action. It explodes if heated in a closed brass case, also on sharp percussion when placed between two metallic surfaces; it should not, therefore, be kept in hermetically sealed receptacles of metal or other very solid material. At a low temperature dynamite loses its tendency to explode by detonation. Another defect is its liability to part with a portion of its nitroglycerin, especially when in contact with porous substances, such as the paper of cartridges and wrappers (see Guyot, *Compt. rend.*, lxxii. 688). MM. Girard, Millot, and Vogt have shown (*Moniteur scientifique*, xiii. 58) that for the manufacture of dynamite the best absorbents are kaolin, tripoli, alumina, and sugar; the last, like alum, the material employed in Mr Horsley's preparation, has the advantage of being separable from associated nitroglycerin by solution in water. Dynamite as made by M. P. Champion consisted of 20 to 25 parts of nitroglycerin with 75 to 80 parts of finely pulverized burnt clay from glass works (*Monit. scient.*, xiii. 91); and in some explosives sold as dynamite a mixture of sawdust and chalk is substituted for siliceous substances.

See F. A. Abel, *On Recent Investigations and Applications of Explosive Agents*, 1871; J. Trauzl, *Die Dynamite, ihre Eigenschaften und Gebrauchsweise*, Berlin, 1876.

DYNAMOMETER (δύναμις, strength, and μέτρον, a measure), an instrument for measuring force exerted by men, animals, and machines. One of the simplest forms, namely, that devised by the mechanician Graham, and improved by Desaguliers, was essentially a steel-yard in which the position of the weight on the longer arm indicated the force exerted on the shorter in order to produce equilibrium. The dynamometer invented by Leroy of the French Academy consisted of a metallic tube 10 to 12 inches long, in which was a spiral spring with an attached graduated rod terminating above in a globe. Pressure being applied to the globe, the rod sank into the tube, and thus marked the force employed in compressing the spring. M. Regnier's dynamometer (see *Journ de l'École Polytechnique*, tom. ii.) consists of an elliptical steel spring having fixed to one of its arms a semicircular graduated brass plate with central index, and to the other a small lever, which, acting on the index, shows the amount of force exerted in effecting a greater or less approximation of the arms to each other. In a similar instrument contrived by M. Poncelet, the springs are hinged together at the extremities, and separated from each other in proportion to the tension brought to bear upon them. A dynamometer for therapeutical purposes, invented by Dr Hamilton of Long Island College Hospital, consists of an india-rubber bulb filled with coloured water, into which dips a tube closed at the upper end. Pressure being applied to the bulb, some of the water is forced up into the tube, the graduations upon which show the amount of pressure upon the air within it which is exerted by the water. By the dynamometer of Colonel Morin a curve is drawn, the area of which represents the product of the force exerted into the space through which it acts, or, in other words, the quantity of work performed in a given time. Details with respect to Morin's, Watt's, and other dynamometers will be found in vol. i. of Laboulaye's *Dictionnaire des Arts et Manufactures.*

DYRRACHIUM. See DURAZZO.

DYSART, a seaport town and royal and parliamentary burgh of Scotland, in the county of Fife, nine miles north-east of Burntisland, with a station on the North British Railway. It consists mainly of three narrow streets with a square in the centre, and on the whole has rather a dull and deserted appearance. In the High Street there are a number of antique houses with inscriptions and dates; and towards the south side of the town there are remains of an ancient chapel. Besides the old parish church with its tower, there are six places of worship, an old town-house, a mechanics' institute, and a combination poorhouse. The harbour is tolerably good, and there is a wet dock attached. The staple industry is the manufacture of linens and ticks; but flax-spinning and ship-building are also carried on, and there is a large export of coal. To the west of the town is Dysart House, the residence of the earl of Rosslyn. As a parliamentary borough Dysart is a member of the Kirkcaldy district. The population of the town in 1871 was 2476.

Dysart is mentioned as early as 874 at the time of a Danish invasion. Its name is said to be a corruption of the Latin *desertum*, a desert, applied to a cave on the sea-shore which was occupied about 440 by St Serf or Sanctus Servanus, to whom at a later date the church was dedicated. From James V. the town received the rights of a royal burgh. In the 15th and 16th centuries it was the seat of a great manufacture of salt, and besides dealing in this article with Holland and other countries, it had a large general trade. For several months in 1559 it was the headquarters of the Lords of the Congregation, and in 1607 it was the scene of those remarkable meetings of the synod of Fife known in ecclesiastical history as the Three Synods of Dysart. William Murray, a native of the town, was made earl of Dysart either by Charles I. or Charles II., and his eldest daughter afterwards assumed the title of countess, and transmitted the dignity to her descendants by the earl of Lauderdale, her second husband.

DYSENTERY (from the prefix δυς, and ἔντερον, the intestine), also called Bloody Flux, an infectious disease with a local lesion in the form of inflammation and ulceration of the lower portion of the bowels.

Although at one time a common disease in Great Britain, dysentery is now very rarely met with there, and is for the most part confined to warm countries, where it is the cause of a large amount of mortality.

Dysentery in a sporadic form may occur anywhere, but this variety of the disease is believed to depend on a different cause from that to which it is due where it prevails endemically or spreads as an epidemic; for, while isolated cases appear capable of being excited by irritating causes which act locally on the alimentary canal, and may thus be developed out of an ordinary intestinal catarrh, the dysentery of tropical climates is generally regarded as owing its origin to a specific poison of the nature of a miasm or germ, somewhat analogous to that which is believed to be the cause of malignant cholera. How, and under what circumstances, the dysentery poison is generated is still a matter of uncertainty. The frequent association of dysentery with intermittent fever has long been remarked, and has led to the belief on the part of many in a malarial origin for this disease. It is, however, doubtful whether any necessary relationship can be established between them (although a malarial form of dysentery is a well marked variety of the disease), since dysentery may be found prevailing where no evidence of malaria can be detected. At the same time

certain characters of climate and soil are known to favour the increase and propagation of dysentery. Long continued high temperature of the air and ground, such as exists in the tropics, together with a soil of swampy character, are the conditions generally present where dysentery prevails endemically, and where it is propagated as an epidemic these factors are seldom absent. Among other causes well recognized as favouring the spread of epidemic dysentery are impure air and water, improper and insufficient food, unripe fruit, excessive indulgence in alcoholic liquors, and exposure to chills in warm weather, all or many of which have been often found connected with the propagation of dysentery among large bodies of people, as in the case of armies, where also the disease has been frequently associated with outbreaks of scurvy.

The contagiousness of epidemic dysentery is generally admitted, and it is probable that in this disease as in cholera the vehicle of its transmission is contained in the matter discharged from the bowels of those affected.

Dysentery manifests itself with varying degrees of intensity, but in well-marked cases the following are the chief symptoms. The attack is commonly preceded by certain premonitory indications in the form of general illness, loss of appetite, and some amount of diarrhœa, which gradually increases in severity, and is accompanied with griping pains in the abdomen (tormina). The discharges from the bowels succeed each other with great frequency, and the painful feeling of pressure downwards (tenesmus) becomes so intense that the patient is constantly desiring to defecate. The matters passed from the bowels, which at first resemble those of ordinary diarrhœa, soon change their character, becoming scanty, mucous or slimy, and subsequently mixed with, or consisting wholly of, blood, along with shreds of exudation thrown off from the mucous membrane of the intestine. The evacuations possess a peculiarly offensive odour characteristic of the disease. Although the constitutional disturbance is at first comparatively slight, it increases with the advance of the disease, and febrile symptoms come on attended with urgent thirst and scanty and painful flow of urine. Along with this the nervous depression is very marked, and the state of prostration to which the patient is reduced can scarcely be exceeded. Should no improvement occur death may take place in from one to three weeks, either from repeated losses of blood, or from gradual exhaustion consequent on the continuance of the symptoms, in which case the discharges from the bowels become more offensive and are passed involuntarily.

When, on the other hand, the disease is checked, the signs of improvement are shown in the cessation of the pain, in the evacuations being less frequent and more natural, and in relief from the state of extreme depression. Convalescence is, however, generally slow, and recovery may be imperfect—the disease continuing in a chronic form, which may exist for a variable length of time, giving rise to much suffering, and not unfrequently leading to an ultimately fatal result.

Several varieties of dysentery are described in which the symptoms are modified by the association of the disease with other morbid conditions. Thus the form known as Malarial Dysentery is complicated with febrile attacks of an intermittent character, and is frequently attended with hepatic, splenic, and renal affections; while it is most successfully treated by remedies which are of value in malarial diseases, such as quinine. Again, in Scorbutic Dysentery the attack is accompanied with the great prostration characteristic of scorbutus, and also with dangerous hemorrhage. Malignant Dysentery is the term applied to those cases where all the symptoms are present in great intensity, and progress rapidly to a fatal termination. Such cases are often attended with gangrene and sloughing of the mucous membrane of the affected portion of the bowel.

The dysentery poison appears to exert its effects upon the glandular structures of the large intestine, particularly in its lower part. In the milder forms of the disease there is simply a congested or inflamed condition of the mucous membrane, with perhaps some inflammatory exudation on its surface, which is passed off by the discharges from the bowels. But in the more severe forms ulceration of the mucous membrane takes place. Commencing in and around the solitary glands of the large intestine in the form of exudations, these ulcers, small at first, enlarge and run into each other, till a large portion of the bowel may be implicated in the ulcerative process. Should the disease be arrested these ulcers may heal entirely, but occasionally they remain, causing more or less disorganization of the coats of the intestines, as is often found in chronic dysentery. Sometimes, though rarely, the ulcers perforate the intestines, causing rapidly fatal inflammation of the peritoneum, or they may erode a blood vessel and produce violent hemorrhage. Even where they undergo healing they may cause such a stricture of the calibre of the intestinal canal as to give rise to the symptoms of obstruction which ultimately prove fatal.

The occurrence of abscess of the liver in connection with attacks of dysentery is frequently observed. It has been ascribed to the passage of morbid material from the diseased intestine into the liver, but by many high authorities is regarded more as a coincidence, depending upon the same climatic causes as those which predispose to the dysentery.

Treatment.—Where the disease is endemic or is prevailing epidemically, it is of great importance to use all preventive measures, and for this purpose the avoidance of all causes likely to precipitate an attack is to be enjoined. Exposure to cold after heat, the use of unripe fruit, and intemperance in eating and drinking should be forbidden; and the utmost care taken as to the quality of the food and drinking water. In houses or hospitals where cases of the disease are under treatment, disinfectants should be freely employed, and the evacuations of the patients removed as speedily as possible. In the milder varieties of this complaint, such as those occurring sporadically, and where the symptoms are probably due to matters in the bowels setting up the dysenteric irritation, the employment of diaphoretic medicines is to be recommended, and the administration of such a laxative as castor-oil, to which a small quantity of laudanum has been added, will often, by removing the source of the mischief, arrest the attack. In the severer forms of the disease, those, namely, occurring in warm climates, the remedy most to be relied on is ipecacuanha. This drug, which has long been known as possessing special efficacy in dysentery (and was originally introduced into this country from Peru as the *radix anti-dysenterica*), has proved of signal value in the treatment of the disease in India, and, as shown by Dr Maclean, has diminished the mortality to a remarkable extent. It is administered in full doses of 25–30 grains of the powder, which are repeated in from six to ten hours, gradually lessening the quantity; the effect observable is a diminution in the pain, and in the frequency and offensive character of the stools, along with the accession of profuse perspiration and quiet sleep. Hot opiate fomentations applied to the abdomen are of use in relieving the tenesmus. Ice may be freely taken to allay thirst. The diet should be light, consisting of soups and farinaceous food. In malarial dysentery quinine is the most successful remedy, ipecacuanha being generally found to be unsuitable; while in scorbutic dysentery the treatment must bear reference to the depraved condition of the general health characteristic of scorbutus. In this form of the disease the fresh bael or bhel fruit (*Ægle Marmelos*) is largely used in India. In chronic dysentery the administration of astringents such as Dover's powder may be of service, but the chief points to be attended to are the nourishing of the patient and the observance of judicious hygienic measures, such as the due clothing of the body, the use of tonics, baths, &c. A change to a cooler climate often proves of great value. (J. O. A.)

DYSPEPSIA (from δυς-, and πέπτω, to digest), or Indigestion, is one of the most common of all complaints, but, from its intimate connection with various other morbid conditions, the term is somewhat vaguely employed. There are comparatively few diseases of any moment where some of the phenomena of dyspepsia are not present as associated symptoms, and not unfrequently these exist to such a degree as to mask the real disease of which they are only complications. This is especially the case in many organic diseases of the alimentary canal, in which the symptoms of dyspepsia are often the most prominent. In its restricted meaning, however (and it is to this that the present brief notice applies), the term is used to describe a functional derangement of the natural process of digestion, apart from any structural change in the organs concerned in the act. The causes of this ailment are very numerous, but are generally regarded as bearing reference either to the food, the condition of the gastric juice, or the movements of the stomach during the process of digestion.

Among the causes connected with the food are not only the indulgence in indigestible articles of diet, but the too common practice of eating too much of what may be otherwise quite wholesome and digestible, irregular or too frequent meals, and imperfect mastication of the food. Substances which are badly cooked, or too hot or too cold, the excessive use of condiments, the partaking of too much liquid with a meal, and over indulgence in tea, tobacco, and alcoholic liquors are likewise fruitful sources of dyspepsia. Morbid states of the gastric juice readily give rise to dyspepsia. This fluid may be diminished in quantity, or be altered in character by the presence of too much acid, or by deficiency in its active digestive principle, pepsine. These conditions are often connected with actual disease of the mucous membrane of the stomach, but they may also exist in advanced life, in depraved states of the general health (as in rheumatism, gout, Bright's disease, anæmia, &c.), or in constitutions weakened by fatigue, over-anxiety, or debauchery. It must, however, be borne in mind that not only the gastric juice but the other digestive fluids, such as the saliva, bile, pancreatic and intestinal juices, may by defects in their amount or quality materially hinder the process of digestion. Further, dyspepsia may be the result of a perverted condition of the natural movements of the stomach during digestion,—whereby, on the one hand, owing to increased activity of its propulsive power, the food may be carried into the intestines in a half dissolved state, and give rise to many of the symptoms of indigestion, or, on the other hand, from a weakened or atonic state of the muscular coats of the stomach digestion may be retarded, and the food retained and excite discomfort and pain consequent on its undergoing fermentive and putrefactive changes.

The symptoms of dyspepsia, even when due to a like cause, are so numerous and diversified in different individuals that probably no description could exactly represent them as they occur in any given case. All that can be here attempted is to mention some of the more prominent morbid phenomena usually present in greater or less degree.

When the attack is dependent on some error in diet, and the dyspepsia consequently more of an acute character, there is often pain followed with sickness and vomiting of the offensive matters, after which the patient soon regains his former healthy state. What are commonly known as "bilious attacks" are frequently of this character. In the more chronic cases of dyspepsia the symptoms are somewhat different. A sensation of discomfort comes on shortly after a meal, and is more of the nature of weight and distension in the stomach than of actual pain, although this too may be present. These feelings may come on after each meal, or only after certain meals, and they may arise irrespective of the kind of food taken, or only after certain articles of diet. As in most of such cases the food is long retained in the stomach, it is apt to undergo fermentive changes, one of the results of which is the accumulation of gases which cause flatulence and eructations of an acid or foul character. Occasionally quantities of hot, sour, tasteless, or bitter fluid, or mouthfuls of half-digested food, regurgitate from the stomach. Temporary relief may be obtained when another meal is taken, but soon the uncomfortable sensations return as before. The appetite is often diminished, but may be little impaired; the tongue is in general large and flabby, and more or less furred. In some forms of this complaint, however, particularly where there is great irritability of the stomach, the tongue is abnormally red. There is generally obstinate constipation.

Numerous disagreeable and painful sensations in other parts are experienced, and are indeed often more distressing than the merely gastric symptoms. Pains in the chest, shortness of breathing, palpitation, headache, giddiness, affections of vision, coldness of the extremities, and general languor are common accompaniments of dyspepsia; while the nervous phenomena are specially troublesome in the form of sleeplessness, irritability, despondency, and hypochondriasis.

A disease of this nature, interfering as it does with the assimilative and nutritive processes, must necessarily exert an evil influence on the general health, and there is reason to believe that many serious ailments owe their origin to persistent dyspepsia. This is notably the case as regards phthisis; for although dyspeptic symptoms often present themselves as complications induced by the disease, yet it cannot be doubted that long-continued indigestion, particularly in youth, must have the effect of favouring the occurrence of consumption in persons at all predisposed to it.

Dyspepsia appears to be in some cases hereditary. In its chronic form, this disease may long resist treatment, but it is always in some measure influenced by the diet and regimen and by the occupation of the patient. As a rule persons of sedentary pursuits and brain-workers suffer more from dyspepsia than those leading active lives.

As regards *treatment* only a few general observations can be made. The careful arrangement of the diet is a matter of first importance. Quantity must be regulated by the digestive capabilities of the individual, his age, and the demands made upon his strength by work. There is little doubt that the danger is in most instances on the side of excess, and the rule which enjoins the cessation from eating before the appetite is satisfied is a safe one for dyspeptics. Due time, too, must be given for the digestion of a meal, and from four to six hours are in general required for this purpose. Long fasts, however, are nearly as hurtful as too frequent meals. Of no less importance is the kind of food taken, and on this point those who suffer from indigestion must ever exercise the greatest care. Every article of diet which past experience has proved to disagree should be shunned, since what may appear trifling indiscretions to this respect are often productive of great and prolonged suffering. The tables which have been framed to show the relative digestibility of various kinds of food, and which

have been founded largely on the observations of Dr Beaumont in the celebrated case of Alexis St Martin, are only valuable within certain limits when applied to the treatment of dyspepsia. It must be borne in mind that idiosyncrasy often plays an important part in digestion, some persons being unable to partake without injury of substances which are generally regarded as wholesome and digestible. Difficulty, too, is often experienced in dealing with dyspeptics from their aversion to, or want of appetite for, those forms of diet which appear most suitable for them. Experience has shown that in this complaint no particular kind of food is absolutely to be relied on, but that in general the best diet is one of a mixed animal and vegetable kind simply but well cooked. The partaking of many dishes, of highly seasoned or salted meats, raw vegetables, newly baked bread, pastry, and confectionery, are all well known common causes of dyspepsia, and should be avoided. When even the simple diet usually taken is found to disagree, it may be necessary to change it temporarily for a still lighter form, such as a milk diet, and that even in very moderate quantity.

General hygienic measures are highly important, since whatever improves the state of the health will have a favourable influence on digestion. Hence regular exercise in the open air, early rising, and the cold bath are to be strongly recommended.

The medicinal remedies for dyspepsia are exceedingly numerous, and a few only of them can be mentioned. Attacks brought on by errors in diet are generally relieved by small doses of rhubarb and bismuth, and by the use of small quantities of light and bland food. In chronic dyspepsia the treatment must depend on the cause of the disorder, so far as that can be ascertained. When the dyspepsia is of the atonic form without much irritability of stomach, bitter tonics such as nux vomica, calumba, gentian, or quassia, along with some of the mineral acids taken before, with, or immediately after a meal will be found highly serviceable; while on the other hand, when there is gastric irritation with acid eructations, sickness, and pain, the medicinal hydrocyanic acid along with bismuth, and antacids taken after food will often afford relief. Pepsine is a remedy of undoubted value in many cases of dyspepsia, and appears to supply the place of that ingredient of the gastric juice when it is deficient in amount. It may be given along with a meal, alone, or in conjunction with diluted hydrochloric acid, which also is a remedy of great efficacy in indigestion. Strict attention must ever be paid to the regular action of the bowels, and where laxatives are required an aloetic dinner pill, or, what is often better, one of the mineral bitter waters (such as that of Friedrichshall) which are now so commonly used, should be had recourse to.

The employment of alcoholic stimulants to assist digestion is largely resorted to both with and without medical advice. While it seems probable that in certain cases of atonic dyspepsia, particularly in the feeble and aged, the moderate administration of alcohol has the effect of stimulating the secretion of gastric juice, and is an important adjuvant to other remedies, the advantages of its habitual use as an aid to digestion by the young and otherwise healthy is more than questionable, and it will generally be found that among them those are least troubled with indigestion who abstain from it. See Physiology and Dietetics. (J.O.A.)

DYVEKE, in German often *Düveke*, and in the Latin chronicles *Columbella*, the "Little Dove," the name by which the mistress of Christian II. of Denmark is invariably designated. Her father was a certain Sigbrit Villums, who had been obliged for political reasons to leave his native country of Holland. Settling at Bergen, he opened an inn, which soon became known for something more than the hospitality of the host or the excellence of his cheer: his daughter's beauty was bush enough for his weakest wine. Valkendorp, the chancellor, did not think it unbecoming of his priestly character to sound her praise in the ears of the young crown-prince; and accordingly, when he visited Bergen in 1507, the prince made a point of seeing the "Little Dove" for himself. In matters of this sort there is unquestionably a royal road; and so having danced with her at a ball or two, he had little difficulty in getting her to leave the inn for a house of her own at Oslo. She followed him to Copenhagen on his accession in 1513, and both her father and mother obtained unusual influence at court. In 1515 the young king, indeed, was constrained from reasons of state to marry Isabella, the sister of Charles V.; but in spite of the emperor's remonstrance, his relations with Dyveke and her parents underwent no real alteration till her sudden death in 1517. That she had been poisoned was the natural verdict of the popular feeling; and the royal suspicion fell on Torben Oxa, warden of the castle of Copenhagen, who was known to have made love to the girl before she was carried off by the prince; and was it not true that two days before her death he had sent her a present of cherries? It mattered not that the culprit was declared innocent by the royal council: "though his neck were as thick as the neck of a bull it should not save his head," raged the king; and he kept his word. Such is the story, not altogether authenticated, which has furnished a favourite theme to dramatist and novelist. Samsoë the Danish poet, published his well-known tragedy "Dyveke" in the close of the 18th century, and it was translated by Manthey into German in 1798. Münch treated the subject in a semi-historical manner in his *Biograph.-histor. Studien*; Hermann Marggraff's tragedy of *Das Taübchen von Amsterdam* appeared in 1839, Rickhoff's *Düveke* in 1842, Hauch's *Wilhelm Zabern* in 1834, Ida Frick's *Sybrecht Willums* in 1843, and Mosenthal's *Düveke* in 1860.

DZUNGARIA, Dsongaria, or Songaria, a former Mongolian kingdom of Central Asia, raised to its highest pitch by Kaldan or Bushtu Khan in the latter half of the 17th century, but completely destroyed by Chinese invasion about 1757–59. It derived its name from the Dsongars, or Songars, who were so called because they formed the left wing (*dson*, left; *gar*, hand) of the Mongolian army. Its widest limit included Kashgar, Yarkand, Khotan, the whole region of the Thian Shan Mountains, and in short the greater proportion of that part of Central Asia which extends from 35° to 50° N. lat. and from 72° to 97° E. long. The name, however, is more properly applied only to the present Chinese province of Thian-Shan-pe-lu and the country watered by the Ili. As a political or geographical term it has practically disappeared from the map; but the range of mountains stretching north-east along the southern frontier of the Land of the Seven Streams—as the district to the south-east of the Balkhash Lake is called—preserves the name of the Dzungarian Range.